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(54) SOLID-STATE IMAGE PICKUP DEVICE AND ITS CONTROL METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To secure a sufficient exposure time through a quick action by reducing the restriction to the exposure time at the time of realizing a whole-picture simultaneous shuttering function by using a solid-state image pickup element having such an element structure as that of a CMOS solid-state image pickup element.

SOLUTION: A discharge Tr 215 which discharges the signal charge of an embedded PD 219 is provided separate from a transfer Tr 211 which transfers the signal charge of the PD 219 to an FD 216. Then both the channel potential when the discharge Tr 215 is turned on and the channel potential when the transfer Tr 211 is turned on are set higher than the completely depleted potential of the PD 219 so that the signal charge of the PD 219 may be transferred completely from both the transfer Tr 211 and discharge Tr 215. Consequently, the exposing action of the PD 219 can be started in the course of

successively reading out signal charges of the pixel line from the FD 216 line by line.

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2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1]

In the solid state image sensor which has the image pick-up field section which prepared two or more pixels, and the processing circuit section which processes the picture signal outputted from said image pick-up field section,

Said pixel has the optoelectric transducer which generates the signal charge according to light income, the floating diffusion section which detects the amount of signal charges generated by said optoelectric transducer, the transfer transistor which transmits the signal charge generated by said optoelectric transducer to said floating diffusion section, and the discharge transistor which discharges the signal charge generated by said said optoelectric transducer,

Said optoelectric transducer is formed from the embedding photodiode which has the charge separation field which consists of a 1st conductivity-type high concentration impurity layer formed in the outermost surface of a semi-conductor

substrate, and the charge storage field which consists of a 2nd conductivity-type impurity layer formed in the lower layer of said charge separation field,

Both the channel potential when turning on said discharge transistor and the channel potential when turning on said transfer transistor were set up so that it might become higher than the perfect depletion-ized potential of said photodiode,

The solid state image sensor characterized by things.

[Claim 2]

The solid state image sensor according to claim 1 characterized by having the reset transistor which resets the signal charge of said floating diffusion section, the magnification transistor which outputs the electrical signal corresponding to the potential of said floating diffusion section, and the selection transistor which activates said magnification transistor alternatively.

[Claim 3]

The solid state image sensor according to claim 1 characterized by impressing the transfer bias voltage for forming the 1st conductivity-type channel layer in the interface of the gate dielectric film of said transfer transistor during the charge storage period in said optoelectric transducer to the gate electrode of said transfer transistor, and impressing the discharge bias voltage for forming the 1st

conductivity-type channel layer in the gate electrode of said discharge transistor during the charge storage period in said optoelectric transducer at the interface of the gate dielectric film of said discharge transistor.

[Claim 4]

After resetting the floating diffusion section of all the pixels in said image pick-up field section to coincidence, The signal charge of the photodiode of all pixels is transmitted to coincidence at the floating diffusion section. Next, the signal charge transmitted to said floating diffusion section is read for every pixel line. While turning on said discharge transistor and discharging the signal charge of the photodiode of all pixels until this read-out actuation progresses to a predetermined exposure initial line The solid state image sensor according to claim 1 characterized by turning off said discharge transistor when it progresses to said predetermined exposure initial line, and starting exposure of all pixels.

[Claim 5]

The solid state image sensor according to claim 4 characterized by for the residual charge of the photodiode immediately after transmitting the signal charge of a photodiode to said floating diffusion section with said transfer transistor being 20 or less charges, and the residual charge of the photodiode

after discharging the signal charge of a photodiode with said discharge transistor being 20 or less charges.

[Claim 6]

The solid state image sensor according to claim 4 with which the gate voltage level at the time of ON of said discharge transistor is characterized by being higher than the gate voltage level at the time of ON of said transfer transistor.

[Claim 7]

The solid state image sensor according to claim 4 characterized by having an electrical potential difference with the gate voltage level higher than the supply voltage of the digital circuit mounted in the solid state image sensor at the time of ON of said discharge transistor.

[Claim 8]

During the actuation which reads the signal charge of said floating diffusion section in the pixel line in front of said exposure initial line, it is the solid state image sensor according to claim 4 characterized by turning off said discharge transistor.

[Claim 9]

The solid state image sensor according to claim 2 characterized by having been

prepared in the direction in which each gate wiring of said transfer transistor, a reset transistor, and a magnification transistor met the pixel line, having driven for every pixel line, having been prepared in the direction in which gate wiring of said discharge transistor met the pixel train, and having connected too hastily [all / pixel] in the exterior of the image pick-up field section further.

[Claim 10]

It has the image pick-up field section which prepared two or more pixels, and the processing circuit section which processes the picture signal outputted from said image pick-up field section,

Said pixel has the optoelectric transducer which generates the signal charge according to light income, the floating diffusion section which detects the amount of signal charges generated by said optoelectric transducer, the transfer transistor which transmits the signal charge generated by said optoelectric transducer to said floating diffusion section, and the discharge transistor which discharges the signal charge generated by said said optoelectric transducer,

Said optoelectric transducer is the control approach of the solid state image sensor formed from the embedding photodiode which has the charge separation field which consists of a 1st conductivity-type high concentration impurity layer

formed in the outermost surface of a semi-conductor substrate, and the charge storage field which consists of a 2nd conductivity-type impurity layer formed in the lower layer of said charge separation field,

Both the channel potential when turning on said discharge transistor and the channel potential when turning on said transfer transistor are set up so that it may become higher than the perfect depletion-ized potential of said photodiode,

The full transfer of the signal charge of said photodiode can be been made to carry out from both a transfer transistor and a discharge transistor, and exposure actuation of said photodiode is started from the signal charge's from said floating diffusion section read-out middle,

The control approach of the solid state image sensor characterized by things.

[Claim 11]

After resetting the floating diffusion section of all the pixels in said image pick-up field section to coincidence, The signal charge of the photodiode of all pixels is transmitted to coincidence at the floating diffusion section. Next, the signal charge transmitted to said floating diffusion section is read for every pixel line.

While turning on said discharge transistor and discharging the signal charge of the photodiode of all pixels until this read-out actuation progresses to a

predetermined exposure initial line The control approach of the solid state image sensor according to claim 10 characterized by turning off said discharge transistor when it progresses to said predetermined exposure initial line, and starting exposure of all pixels.

[Claim 12]

The control approach of the solid state image sensor according to claim 11 characterized by for the residual charge of the photodiode immediately after transmitting the signal charge of a photodiode to said floating diffusion section with said transfer transistor being 20 or less charges, and the residual charge of the photodiode after discharging the signal charge of a photodiode with said discharge transistor being 20 or less charges.

[Claim 13]

The control approach of a solid state image sensor according to claim 11 that the gate voltage level at the time of ON of said discharge transistor is characterized by being higher than the gate voltage level at the time of ON of said transfer transistor.

[Claim 14]

The control approach of the solid state image sensor according to claim 11

characterized by having an electrical potential difference with the gate voltage level higher than the supply voltage of the digital circuit mounted in the solid state image sensor at the time of ON of said discharge transistor.

[Claim 15]

During the actuation which reads the signal charge of said floating diffusion section in the pixel in front of said exposure initial line, it is the control approach of the solid state image sensor according to claim 11 characterized by turning off said discharge transistor.

[Claim 16]

In the camera equipment which outputs the image picturized with the solid state image sensor,

Said solid state image sensor has the image pick-up field section which prepared two or more pixels, and the processing circuit section which processes the picture signal outputted from said image pick-up field section,

Said pixel has the optoelectric transducer which generates the signal charge according to light income, the floating diffusion section which detects the amount of signal charges generated by said optoelectric transducer, the transfer transistor which transmits the signal charge generated by said optoelectric

transducer to said floating diffusion section, and the discharge transistor which discharges the signal charge generated by said said optoelectric transducer,

Said optoelectric transducer is formed from the embedding photodiode which has the charge separation field which consists of a 1st conductivity-type high concentration impurity layer formed in the outermost surface of a semi-conductor substrate, and the charge storage field which consists of a 2nd conductivity-type impurity layer formed in the lower layer of said charge separation field,

Both the channel potential when turning on said discharge transistor and the channel potential when turning on said transfer transistor were set up so that it might become higher than the perfect depletion-ized potential of said photodiode,

Camera equipment characterized by things.

[Claim 17]

Said solid state image sensor is camera equipment according to claim 16 characterized by having the reset transistor which resets the signal charge of said floating diffusion section, the magnification transistor which outputs the electrical signal corresponding to the potential of said floating diffusion section, and the selection transistor which activates said magnification transistor alternatively.

[Claim 18]

Said solid state image sensor is camera equipment according to claim 16 characterized by to impress the transfer bias voltage for forming the 1st conductivity-type channel layer in the interface of the gate dielectric film of said transfer transistor during the charge storage period in said optoelectric transducer to the gate electrode of said transfer transistor, and to impress the discharge bias voltage for forming the 1st conductivity-type channel layer in the gate electrode of said discharge transistor during the charge storage period in said optoelectric transducer at the interface of the gate dielectric film of said discharge transistor.

[Claim 19]

After said solid state image sensor resets the floating diffusion section of all the pixels in said image pick-up field section to coincidence, The signal charge of the photodiode of all pixels is transmitted to coincidence at the floating diffusion section. Next, the signal charge transmitted to said floating diffusion section is read for every pixel line. While turning on said discharge transistor and discharging the signal charge of the photodiode of all pixels until this read-out actuation progresses to a predetermined exposure initial line Camera equipment

according to claim 16 characterized by turning off said discharge transistor when it progresses to said predetermined exposure initial line, and starting exposure of all pixels.

[Claim 20]

Said solid state image sensor is camera equipment according to claim 19 characterized by for the residual charge of the photodiode immediately after transmitting the signal charge of a photodiode to said floating diffusion section with said transfer transistor being 20 or less charges, and the residual charge of the photodiode after discharging the signal charge of a photodiode with said discharge transistor being 20 or less charges.

[Claim 21]

Said solid state image sensor is camera equipment according to claim 19 with which the gate voltage level at the time of ON of said discharge transistor is characterized by being higher than the gate voltage level at the time of ON of said transfer transistor.

[Claim 22]

Said solid state image sensor is camera equipment according to claim 19 characterized by having an electrical potential difference with the gate voltage

level higher than the supply voltage of the digital circuit mounted in the solid state image sensor at the time of ON of said discharge transistor.

[Claim 23]

Said solid state image sensor is camera equipment according to claim 19 characterized by turning off said discharge transistor during the actuation which reads the signal charge of said floating diffusion section in the pixel line in front of said exposure initial line.

[Claim 24]

Said solid state image sensor is camera equipment according to claim 17 characterized by having been prepared in the direction in which each gate wiring of said transfer transistor, a reset transistor, and a magnification transistor met the pixel line, having driven for every pixel line, having been prepared in the direction in which gate wiring of said discharge transistor met the pixel train, and having connected too hastily [all / pixel] in the exterior of the image pick-up field section further.

[Claim 25]

Camera equipment according to claim 16 characterized by having the switch means which switches shutter actuation of said solid state image sensor in focal

plane shutter actuation and all pixel coincidence shutter actuation.

[Claim 26]

Camera equipment according to claim 19 characterized by having an exposure-time selection means to choose the exposure time in said solid state image sensor, and an exposure initial line selection means to choose said predetermined exposure initial line based on the exposure time chosen by said exposure-time selection means.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to a solid state image sensor and its control approaches, such as CMOS mold image sensors equipped with electronic shutter ability.

[0002]

[Description of the Prior Art]

Conventionally, although many CMOS mold image sensors are equipped with electronic shutter ability, since it is the focal plane shutter (rolling shutter) which scans sequentially the pixel of a large number by which two-dimensional array was carried out unlike CCD mold image sensors for every pixel line, and resets a signal, the technical problem that an exposure period shifts for every screen line occurs.

When it is photoed that the object straight in the vertical direction is moving to

the longitudinal direction in this case, it will be reflected as it leans.

As the image which drawing 7 (A) be the explanatory view show that situation, and will perform in order actuation which carry out a transfer output (signal read-out) after reset of each line and the predetermined exposure time in each line, consequently be obtain be show in drawing 7 (C), the straight body a will be reflect in the vertical direction currently move to the longitudinal direction in the condition of having incline.

[0003]

What goes out a shutter to all line coincidence exists to it. In that case, a photodiode (PD) is reset to all line coincidence at a certain time, and the charge of PD is transmitted to all line coincidence after the predetermined exposure time at floating diffusion (FD). It outputs the signal of this FD one line at a time in order.

Drawing 7 (B) is the explanatory view showing the situation, after package reset of all lines, carries out all line coincidence transfers, and outputs for every line after that. Even when carrying out like this and the straight object a is photoed in the vertical direction currently moved to the longitudinal direction as shown, for example in drawing 7 (D), it is straight **** too.

[0004]

Moreover, the thing equipped with the transistor (discharge Tr) which can discharge the surplus charge of PD to a direct drain as pixel circuitry for carrying out coincidence reset of the signal charge of the photodiode (PD) of all pixels with CMOS mold image sensors, without going via FD is also proposed (patent reference 1 reference).

[0005]

[Patent reference 1]

JP,2001-238132,A

[0006]

[Problem(s) to be Solved by the Invention]

However, there were the following problems in the CMOS mold image sensors of all the pixel shutter methods shown in drawing 7 (B).

(1) Light differs in the line which a leakage lump and its amount will output to FD previously by the time it outputs in order for every pixel line, after transmitting to all line coincidence, and the line outputted later, and worsens a photography image.

(2) Since PD is reset after outputting the information on all lines, it cannot

expose after transmitting to all line coincidence until it finishes outputting the information on all lines one line at a time, but time amount becomes useless. Moreover, since it is difficult to take the large exposure time, when a photographic subject is dark, sensibility falls.

[0007]

Hereafter, these troubles are explained to a detail.

First, although the amount of the light which leaks to FD is also almost 0 in a head line since the time amount die length to an output differs by the one-frame read time about the above (1) after transmitting in the line outputted to a head, and the line outputted to the last, it becomes the amount of leakage lumps for an one-frame read time in a last line.

Since photo electric conversion also of the FD is carried out, the charge corresponding to the quantity of light will collect on FD, and this will join the signal charge transmitted from PD.

This will also exceed the amount of saturated signals, when light is strong, and it will make it it not only to become a noise and shading, but white-fly. thus, the light to FD -- leaking -- being crowded -- a photography image is worsened remarkably.

[0008]

In relation to this, it explains using drawing 8 and drawing 9 .

First, drawing 8 is the sectional view showing the structure of the photodiode periphery of the conventional CCD mold solid state image sensor.

A photodiode (PD) 12, the read-out channel section 14, the channel stop section 16, and perpendicular transfer register 18 grade are formed in the management of the semi-conductor substrate 10, the polish recon transfer electrode 22 is arranged through gate dielectric film 20 on the top face of the semi-conductor substrate 10, and, as for this CCD mold solid state image sensor, the light-shielding film 26 is further arranged through the insulator layer 24 in that upper part.

Opening 26A corresponding to the light-receiving side of PD12 is formed in the light-shielding film 26. Moreover, on this light-shielding film 26, the flattening film (the upper insulator layer) 28 is formed, and that upper layer is equipped with the color filter 30 and the micro lens 32.

[0009]

In such a CCD mold solid state image sensor, the photoelectrical load of PD12 is read to whole surface coincidence, and is transmitted to the perpendicular

transfer register 18 through the channel section 14.

Then, to the output amplifier section (not shown), the photoelectrical load of one line is carried at a time by CCD of the perpendicular transfer register 18, and is outputted.

Metal layers, such as aluminum used as a light-shielding film 26, are dropped to the latest of PD12, and it is made for light not to leak to the perpendicular transfer register 18 with a CCD mold solid state image sensor like illustration. It becomes vertical-reinforcement-like the cause of image degradation that light is called a leakage lump to the perpendicular transfer register 18, and this is still slightly called a smear.

[0010]

Next, drawing 9 is the sectional view showing the structure of the photodiode periphery of the conventional CMOS mold solid state image sensor.

P well fields 42 and 44 as a component formation field are formed in the management of the semi-conductor substrate (N type silicon substrate) 40, and, as for this CMOS mold solid state image sensor, PD46 and various kinds of gate components are formed in P well fields 42 and 44. In addition, PD46, the transfer gate (MOS transistor) 48, and FD50 are formed in P well field 42, and, as for the

example of illustration, MOS transistor 52 of the circumference circuit section is formed in P well field 44.

Moreover, on the semi-conductor substrate 40, the polish recon transfer electrode 56 of each gate is formed through gate dielectric film 54, and the multilayer-interconnection layers 60, 62, and 64 are further formed in the upper layer through the interlayer insulation film 58. And the wiring film of the upper film 64 of this multilayer-interconnection layer is formed as a light-shielding film.

Moreover, on the multilayer-interconnection layer, the color filter 72 and the micro lens 74 are arranged through the protective coat (SiN) 70.

[0011]

Thus, in a CMOS mold solid state image sensor, since a pixel is also made using the same CMOS process as a circumference circuit, a light-shielding film (wiring layer 64) cannot be dropped to the latest of PD46, and things cannot perform building the structure of carrying out incidence of the light only to PD46.

Moreover, since there is a many layers metal wiring layer, light will reflect irregularly on each class. For this reason, compared with the case of a CCD mold solid state image sensor, a lot of light will leak to FD50 so that drawing 9 may show.

Thus, in a CMOS mold solid state image sensor, there is a problem that image degradation at the time of transmitting to all line coincidence is intense.

[0012]

Next, reset of PD is performed by discharging the charge of PD to FD about the above (2). If it is in the condition that the signal is held at FD, at this time, since this signal will break, reset of PD cannot be performed, if it is not after reading the signal of FD of all lines.

Then, there was also a CMOS sensor equipped with the transistor (discharge Tr) which can discharge the surplus charge of PD to a direct drain, without going via FD so that it might be indicated by the patent reference 1 mentioned above, but after performing reset of the mist [this] beam PD via FD and reading the signal of FD of all lines therefore, when PD was not reset, the image had deteriorated.

That is because cannot arrange properties, such as a threshold of the above-mentioned discharge Tr, with the transfer Tr which transmits the charge of PD to FD completely, so problems which do not return to the condition reset PD and the difference cannot remove in a next circuit, such as a fixed pattern noise and an after-image, will generate when transmitting a charge to the last of an are-recording period by Transfer Tr at FD if PD is reset by Discharge Tr to the

beginning of an are-recording period.

Therefore, since reset of PD cannot be performed in between [until it reads the signal of FD of all lines too] and it is not made at an exposure period in order to obtain a good image, sensibility will be dropped.

[0013]

Furthermore, when PD was reset by Discharge Tr while having read the signal of FD, the conditions of a pixel differed delicately in the back before resetting PD other than the above-mentioned problem, and, also in the trouble that a lateral stripe will be visible to the part with a photography image, a certain thing became clear.

Moreover, when there was discharge Tr, also in the trouble of the dark current occurring from the oxide-film interface under the gate, and flowing into PD, a certain thing became clear.

[0014]

Then, when realize full screen coincidence shutter ability using the solid state image sensor which have component structure like the CMOS mold solid state image sensor mentioned above, it mitigate the constraint which the exposure time receive, and the purpose of this invention secure exposure time sufficient in

quick actuation, decrease relatively the amount of noises by leakage lump of light, and be to offer the solid state image sensor which can perform a good image output, and its control approach.

[0015]

[Means for Solving the Problem]

In the solid state image sensor which has the image pick-up field section which prepared two or more pixels, and the processing circuit section which processes the picture signal outputted from said image pick-up field section in order that this invention may attain said purpose The optoelectric transducer to which said pixel generates the signal charge according to light income, and the floating diffusion section which detects the amount of signal charges generated by said optoelectric transducer, The transfer transistor which transmits the signal charge generated by said optoelectric transducer to said floating diffusion section, It has the discharge transistor which discharges the signal charge generated by said said optoelectric transducer. Said optoelectric transducer The charge separation field which consists of a 1st conductivity-type high concentration impurity layer formed in the outermost surface of a semi-conductor substrate, The channel potential when being formed from the embedding photodiode which has the

charge storage field which consists of a 2nd conductivity-type impurity layer formed in the lower layer of said charge separation field, and turning on said discharge transistor, It is characterized by setting up both channel potentials when turning on said transfer transistor so that it may become higher than the perfect depletion-ized potential of said photodiode.

[0016]

This invention has the image pick-up field section which prepared two or more pixels, and the processing circuit section which processes the picture signal outputted from said image pick-up field section. Moreover, said pixel The optoelectric transducer which generates the signal charge according to light income, and the floating diffusion section which detects the amount of signal charges generated by said optoelectric transducer, The transfer transistor which transmits the signal charge generated by said optoelectric transducer to said floating diffusion section, It has the discharge transistor which discharges the signal charge generated by said said optoelectric transducer. Said optoelectric transducer The charge separation field which consists of a 1st conductivity-type high concentration impurity layer formed in the outermost surface of a semi-conductor substrate, It is the control approach of the solid state image

sensor formed from the embedding photodiode which has the charge storage field which consists of a 2nd conductivity-type impurity layer formed in the lower layer of said charge separation field. Both the channel potential when turning on said discharge transistor and the channel potential when turning on said transfer transistor are set up so that it may become higher than the perfect depletion-ized potential of said photodiode. The full transfer of the signal charge of said photodiode can be been made to carry out from both a transfer transistor and a discharge transistor, and it is characterized by starting exposure actuation of said photodiode from the signal charge's from said floating diffusion section read-out middle.

[0017]

In the camera equipment which outputs the image which picturized this invention with the solid state image sensor moreover, said solid state image sensor It has the image pick-up field section which prepared two or more pixels, and the processing circuit section which processes the picture signal outputted from said image pick-up field section. Said pixel The optoelectric transducer which generates the signal charge according to light income, and the floating diffusion section which detects the amount of signal charges generated by said

optoelectric transducer, The transfer transistor which transmits the signal charge generated by said optoelectric transducer to said floating diffusion section, It has the discharge transistor which discharges the signal charge generated by said said optoelectric transducer. Said optoelectric transducer The charge separation field which consists of a 1st conductivity-type high concentration impurity layer formed in the outermost surface of a semi-conductor substrate, The channel potential when being formed from the embedding photodiode which has the charge storage field which consists of a 2nd conductivity-type impurity layer formed in the lower layer of said charge separation field, and turning on said discharge transistor, It is characterized by setting up both channel potentials when turning on said transfer transistor so that it may become higher than the perfect depletion-ized potential of said photodiode.

[0018]

By the solid state image sensor and its control approach of this invention The transfer transistor which transmits the signal charge of the embedding photodiode used as the optoelectric transducer of each pixel to the floating diffusion section independently The channel potential when preparing the discharge transistor for discharging the signal charge of an embedding

photodiode, and turning on a discharge transistor, It could be made to carry out by setting up both channel potentials when turning on a transfer transistor so that it may become higher than the perfect depletion-ized potential of a photodiode the full transfer of the signal charge of a photodiode from both the transfer transistor and the discharge transistor.

[0019]

Therefore, in order to perform photography without the inclination of the photographic subject which moves, after performing all pixel coincidence shutter actuation and transfer operation, in the actuation which reads a signal charge from the floating diffusion section one by one per pixel line, it becomes possible from the read-out middle to start exposure actuation of a photodiode, exposure time sufficient in quick actuation is secured, and the good image output of high sensitivity can be realized. Moreover, by reservation, the amount of noises according sufficient exposure time to a leakage lump of light can be decreased relatively, and a good image output can be realized also from this point.

Moreover, in the camera equipment carrying such a solid state image sensor, sufficient exposure time is secured and the good image output of high sensitivity can be realized similarly.

[0020]

[Embodiment of the Invention]

Hereafter, the solid state image sensor by this invention, camera equipment, and the example of a gestalt of operation of the control approach are explained.

The example of a gestalt of this operation can be made to carry out are recording initiation from the middle of having read the signal of FD by being able to perfect-reset and enabling it to transmit the charge which made the component structure which established the discharge gate and the transfer gate in the both sides of PD of a CMOS solid state image sensor, and was accumulated in PD at both the discharge gate and the transfer gate.

Moreover, prevention of the dark current is aimed at by impressing a negative electrical potential difference to the discharge gate and the transfer gate.

[0021]

Drawing 1 is the block diagram showing the example of the camera structure of a system by the example of a gestalt of operation of this invention.

This camera system has the image pick-up lens system 101, a solid state image sensor 102, an analog circuit 103, A/D converter 104, the camera digital disposal circuit 105, the compression expansion circuit 106, and the storage 107.

First, image formation of the beam of light which carried out incidence from the image pick-up lens system 101 is carried out to the two-dimensional pixel array of a solid state image sensor 102. Solid state image sensors 102 are components, such as CMOS mold image sensors, and have all the pixel coincidence shutter ability (reset and FD transfer) used as the description of the gestalt of this operation, and a line sequential read-out function from FD.

[0022]

In an analog circuit 103, CDS (correlation duplex sampling), AGC (automatic gain control), etc. are processed. And the picture signal processed in this analog circuit 103 is changed into digital data from analog data by A/D converter 104, and is outputted to the camera digital disposal circuit 105.

In the camera digital disposal circuit 105, it is the circuit which performs signal processing, such as chrominance-signal processing for changing into a video signal from the output data of a solid state image sensor 102, gain control processing, and white balance processing.

A compression expansion circuit 106 is a circuit changed into the format which performs the compression or expanding of image data processed by the camera digital disposal circuit 105, and can memorize an image to a storage 107.

Although a storage 107 is a memory stick etc. and is the example of the means to which image data is made to output, they may be a display panel, various networks, etc., for example.

[0023]

Moreover, drawing 2 is the block diagram showing the example of a configuration of the solid state image sensor 102 and analog circuit 103 which are shown in drawing 1 .

Like illustration, the solid state image sensor of this example prepares a picture element part (image pick-up field section) 210, the constant current section 220, the multiple-message-transmission number processing section (column section) 230, (Perpendicular V) selection driving means 240, (Horizontal H) selection means 250, the level signal line 260, the output-processing section 270, and (timing generator TG) 280 grade on the semiconductor device substrate 200.

A picture element part 210 arranges many pixels in the shape of a two-dimensional matrix, and the pixel circuit as shown in each pixel at drawing 3 is prepared. The signal of each pixel from this picture element part 210 is outputted to the multiple-message-transmission number processing section 230 through a perpendicular signal line (it omits in drawing 2) for every pixel train.

The constant current source (it omits in drawing 2) for supplying a bias current to each pixel is arranged for every pixel train at the constant current section 220. V selection driving means 240 chooses each pixel of one line of a picture element part 210 at a time, and carries out drive control of shutter actuation and read-out actuation of each pixel.

[0024]

The multiple-message-transmission number processing section 230 performs predetermined signal processing of every one line for the signal of each pixel obtained through a perpendicular signal line for every reception and train, and holds the signal temporarily. For example, CDS (fixed pattern noise resulting from dispersion in threshold of pixel transistor is removed) processing, AGC (automatic gain control) processing, A/D-conversion processing, etc. shall be performed suitably.

H selection means 250 chooses every one signal of the multiple-message-transmission number processing section 230, and leads it to the level signal line 260.

The output-processing section 270 carries out predetermined processing to a signal from the level signal line 160, outputs it outside, and has the gain control

circuit and the color processing circuit. In addition, it may be made to carry out in the output-processing section 270 instead of performing A/D conversion in the multiple-message-transmission number processing section 230.

A timing generator 280 supplies various kinds of pulse signals required for actuation of each part etc. based on a reference clock.

[0025]

Moreover, drawing 3 is the circuit diagram showing the example of a configuration of the pixel circuit established in each pixel of the solid state image sensor shown in drawing 2 .

illustration -- a configuration -- each -- a pixel -- a photodiode -- (-- PD --) -- 219 -- a transfer -- magnification -- selection -- reset -- discharge -- five -- a ** -- a pixel -- a transistor -- (-- Tr --) -- 211 -- 212 -- 213 -- 214 -- 215 -- preparing .

PD219 transmits the electron of PD219 to the floating diffusion (FD) 216 by accumulating the electron generated by photo electric conversion and turning on transfer Tr211. Since there is parasitic capacitance in FD216, photoelectrons are collected here.

[0026]

The gate is connected with FD216 and magnification Tr212 changes potential

fluctuation of FD216 into an electrical signal. Since the constant current source 218 which has led to the perpendicular signal line 217 outside magnification Tr212 and a pixel constructs a source follower when selection Tr213 chooses the pixel which reads a signal per line and this selection Tr213 turns on, the electrical potential difference interlocked with the electrical potential difference of FD216 is outputted to a perpendicular signal line.

Reset Tr214 resets the potential of FD216 to wiring of Vdd.

Discharge Tr215 resets the photoelectron of PD219 to wiring of a power source Vdd directly. And wiring of a power source Vdd is common to all pixels.

[0027]

Moreover, the wiring 211A, 213A, and 214A of transfer Tr211, selection Tr213, and reset Tr214 extends in a longitudinal direction (horizontal = line writing direction), and drives to coincidence the pixel contained in the same line. Thereby, it can respond also to the drive of a focal plane shutter.

Moreover, although wiring 215A of discharge Tr215 is extended perpendicularly, it is short-circuited altogether in the upper limit lower limit of a picture element part, and is common to all pixels.

[0028]

Next, PD of a pad mold is used as PD219. In the case of the photodiode for example, in P well, PD of a pad mold makes it p+ mold field near the interface of gate oxide, and forms n mold field in the bottom of it. Since the interface is covered in p+ field, the dark current generated in an interface can be prevented. Moreover, if the design of transfers Tr211 and PD219 is made suitable, since all the photoelectrons of PD219 can be transmitted to FD216, it is the structure currently widely used by the CCD mold sensor. For example, it is commercialized by name called HAD (Hole Accumulation Diode).

[0029]

And in the CMOS mold solid state image sensor of such a configuration, the matter used as the description of this example is having adjusted each gate voltage of Tr 211 and 215, the threshold, and the dose of PD219 so that it might become higher than the perfect depletion-ized potential of PD219 of a pad mold in both the channel potential when turning on discharge Tr215, and the channel potential when turning on transfer Tr211.

By this, in transfer Tr211, the photoelectron of PD219 can be mostly transmitted to FD216 altogether, and the photoelectron of PD219 can be mostly discharged to a drain altogether by discharge Tr215.

Here, mostly, in the case of the image which bears appreciation of human beings, such as a digital camera, if a residual electron is about 20 or less pieces, since it is good, all are semantics including the case where such a residual electron is produced.

[0030]

It is difficult to prepare in the property which can generally carry out the full transfer of both of two Tr(s) to one embedding PD. Moreover, what can carry out the full transfer of the transfer Tr already exists. So, by this example, it can be made to carry out by raising rather than transfer Tr211 the full transfer of the gate voltage at the time of ON of discharge Tr215 also here.

It is realizable by making this especially higher than the supply voltage's of the digital circuit by which on chip was carried out to the solid state image sensor supplying another power source from the outside of a solid state image sensor preferably therefore, or establishing a booster circuit in the interior.

[0031]

Moreover, in the solid state image sensor of the above structures, this artificer etc. be apply the negative electrical potential difference (here, it be call transfer bias voltage) of -1V at the time of OFF of a transfer gate electrode, and have

propose control the dark current (current which use as a component the electron which flow into PD even if light do not carry out incidence) from the interface under the transfer gate section.

This is because the channel of P type is formed in the interface of the gate oxide in the transfer gate section and the dark current from interface state density can be prevented like embedding PD by carrying out bias of the transfer gate electrode to a negative electrical potential difference.

So, in the example of a gestalt of this operation, while impressing a negative electrical potential difference to the gate electrode of Transfer Tr, the dark current in both Tr(s) is removed proper by impressing a negative electrical potential difference (here, it being called discharge bias voltage) also like the gate electrode of Discharge Tr. In addition, 0V of criteria are GND and P well field has also become 0V.

Thus, by impressing a negative electrical potential difference to the gate electrode of Discharge Tr, it was checked by the observation that effectiveness equivalent to the case where a negative electrical potential difference is impressed to the gate electrode of Transfer Tr is acquired.

[0032]

Next, actuation of the solid state image sensor by the example of a gestalt of this operation is explained.

Drawing 4 is a timing chart which shows actuation of the solid state image sensor of this example.

First, the transfer to FD216 of reset of FD216 and the photoelectron of PD219 is performed to all line coincidence. Specifically a pulse is put into reset wiring 214A of all lines, FD216 of all pixels is reset, a pulse is further put into transfer wiring 211A of all lines, and the photoelectron of PD219 of all pixels is transmitted to FD216.

And it reads the signal of FD216 one line at a time. Since it is decided here that the periods of one frame will be some fixed periods, such as 1 / 30 etc. seconds, after reading all lines, time amount is adjusted with a dummy output etc.

[0033]

with the conventional technique, the exposure period was able to be taken as mentioned above only at this dummy period after carrying out all line reading appearance. In this example, when it has still read one line at a time, it can set up an exposure period from from. Hereafter, the detail is explained.

Here, a non-exposing period and it or subsequent ones consider as an exposure

period, and even the n-th line of one frame gives sequential explanation of actuation to the n-1st line, the n-th-line actuation, and the actuation after the n+1st line.

[0034]

(1) Up to the n-1st line :

ON of selection Tr213 outputs the electrical potential difference corresponding to the potential of FD216 of the line to the perpendicular signal line 217. This signal is incorporated to the multiple-message-transmission number processing circuit 230 by the sample hold pulse SHD supplied by the multiple-message-transmission number processing circuit 230. And a reset pulse is put in and FD216 of the line is reset.

Thereby, since the electrical potential difference corresponding to the reset potential of FD216 is outputted to the perpendicular signal line 217, this is again incorporated to the multiple-message-transmission number processing circuit 230 by the sample hold pulse SHR supplied by the multiple-message-transmission number processing circuit 230.

Since these differences are signals, in the multiple-message-transmission number processing circuit 230, difference is taken or the above signal

processing is performed.

Discharge Tr215 turns off the read-out period to the multiple-message-transmission number processing circuit 230, and turns on in other time amount, and the electron of PD219 is discharged to a drain. the gate of this discharge Tr215 -- above -- all pixel ropes -- **** -- since it is, all PDs219 are reset.

[0035]

(2) The n-th line :

Read-out actuation of a signal is the same. Discharge Tr215 is always turned off bordering on this line. The photoelectron of here to PD219 remains collecting on PD219, and becomes an exposure period.

(3) The n+1st line or subsequent ones :

Read-out actuation of a signal is the same. Moreover, discharge Tr215 is always OFF.

[0036]

Drawing 5 is the sectional view showing PD and the structure of a periphery of the solid state image sensor in this example.

This solid state image sensor forms each component in P well field 310

established in the silicon substrate 300, and shows the field in which PD219, FD216, transfer Tr211, reset Tr214, and discharge Tr215 were formed, by drawing 5 .

PD219 is PD of an embedding mold (HAD structure) which has p+ field 219A formed in the outermost surface of a silicon substrate 300, and n field 219B formed in the lower layer.

FD216 consists of an n+ field formed in the side of PD219 through the transfer gate section (transfer Tr211).

[0037]

Transfer Tr211 makes the staging area of PD219 and FD216 the transfer gate section, and forms in the top face of the silicon substrate 300 transfer electrode 211B which consists of polish recon film through gate dielectric film 320.

Reset Tr214 makes the transfer Tr211 of FD216, and the field of the opposite side the reset gate section, forms in the top face of the silicon substrate 300 reset electrode 214B which consists of polish recon film through gate dielectric film 320, and discharges the signal charge of FD216 to drain 214C. It connects with wiring of a power source Vdd through the contact which this drain 214C does not illustrate.

[0038]

Discharge Tr215 makes the transfer Tr211 of PD219, and the field of the opposite side the discharge gate section, forms in the top face of the silicon substrate 300 discharge electrode 215B which consists of polish recon film through gate dielectric film 320, and outputs the signal charge of PD219 to drain 215C. It connects with wiring of a power source Vdd through the contact which this drain 215C does not illustrate.

In addition, although the upper laminated material is further prepared in the upper layer of each electrodes 211B, 214B, and 215B through the insulator layer 330, since it is not directly related to this invention, explanation is omitted.

[0039]

Drawing 6 is the explanatory view showing the potential transition at the time of charge read-out in such a solid state image sensor, and shows forward potential downward.

Drawing 6 (1) is the potential immediately after [all] pixel reset, and the photoelectrical load is gradually accumulated in each PD219. Drawing 6 (2) turns on transfer Tr211, sets the channel electrical potential difference of the transfer gate to Va, and moves the photoelectrical load of PD219 to FD216.

Drawing 6 (3) shows the condition of the non-exposure time after a transfer, and, as for discharge Tr215, the photoelectrical load is gradually accumulated in each PD219 with OFF.

Next, drawing 6 (4) shows the condition of having turned on discharge Tr215, sets the channel electrical potential difference of the discharge gate to Vb, and outputs the photoelectrical load of PD219 to drain 215C of discharge Tr215. In addition, full coincidence of the property of transfer Tr211 and discharge Tr215 cannot be carried out, and Vb and Va serve as a different value (in the example of illustration, it is Vb>Va (drawing 6 facing down)).

[0040]

PD219 is HAD structure, and the 1st focus in the example of a gestalt of these above operations has a channel electrical potential difference higher than the depletion-ized potential of PD219 at the time of ON of discharge Tr215, and is being able to discharge the electron of PD219 altogether mostly. Since the residual electron of PD219 is set to about 0 by this, even if the property of discharge Tr215 varies, big dispersion does not occur in the initial state of PD219.

Moreover, the channel electrical potential difference at the time of ON of transfer

Tr211 of the 2nd focus is also higher than the depletion-ized potential of PD219, and it is being able to transmit the electron of PD219 altogether mostly. Since the residual electron of PD219 is set to about 0 by this, even if the property of transfer Tr211 varies, big dispersion does not occur in the condition after a transfer of PD219.

[0041]

Since the condition the time of are recording initiation of PD219 and after a transfer becomes almost equal, in spite of specifying both with a different transistor by these two focus, a good picture signal is acquired.

Therefore, avoiding aggravation of image quality, it becomes possible to specify exposure initiation by discharge Tr215, and when having still read the signal of FD216 one line at a time, exposure can be started.

And according to the brightness of a photographic subject, the value of the exposure initial line n can be controlled now to adjustable, and exposure initiation can be set as every period of one frame.

In addition, during read-out in the multiple-message-transmission number processing circuit 230, discharge Tr215 is turned off also in the non-exposing period. If turned on at this time, the output of a pixel will be influenced delicately.

Consequently, by the output image, the signal from the n-th line will differ even from the n-th line delicately, and a lateral stripe will appear there. In order to prevent this, discharge Tr215 is turned off during the output of a pixel at least in a non-exposing period as well as an exposure period.

[0042]

The following effectiveness can be acquired when beginning and the end of the exposure period of a full screen realize the so-called coincidence shutter which becomes the same by the CMOS sensor by above configurations and actuation.

(1) Since aggravation of an image can be prevented even if it resets PD while outputting the information on all lines, it can use for an exposure period, avoiding aggravation of image quality after transmitting to all line coincidence also until it finishes outputting the information on all lines one line at a time, and sensibility can be raised by sufficient exposure time.

(2) It can prevent that striping goes into a photography image in the case of actuation by the above (1).

(3) By making gate voltage at the time of OFF of Discharge Tr into a negative electrical potential difference in addition to Transfer Tr, the dark current can be reduced sharply.

[0043]

In addition, although the above was explained as the configuration and actuation of the CMOS mold solid state image sensor formed in camera equipment, this invention can be similarly carried out as the solid state image sensor and its control approach of a simple substance.

Moreover, it is also possible to choose all pixel coincidence shutter actuation mentioned above and the conventional focal plane shutter actuation, and to make it use, and it is also possible to prepare the actuation key which a user can choose and to consider as a selection means.

Moreover, it is also possible for a user to prepare the actuation key which can be chosen suitably and to consider as a selection means also with the exposure time mentioned above, and it is possible for it to be made to perform control which chooses the exposure initial line mentioned above according to the exposure time chosen by this user.

[0044]

[Effect of the Invention]

As explained above, by the solid state image sensor and its control approach of this invention The transfer transistor which transmits the signal charge of the

embedding mold photodiode used as the optoelectric transducer of each pixel to the floating diffusion section independently The channel potential when preparing the discharge transistor for discharging the signal charge of an embedding mold photodiode, and turning on a discharge transistor, It could be made to carry out by setting up both channel potentials when turning on a transfer transistor so that it may become higher than the perfect depletion-ized potential of a photodiode the full transfer of the signal charge of a photodiode from both the transfer transistor and the discharge transistor.

[0045]

Therefore, in order to perform photography without the inclination of the photographic subject which moves, after performing all pixel coincidence shutter actuation and transfer operation, in the actuation which reads a signal charge from the floating diffusion section one by one per pixel line, it becomes possible from the read-out middle to start exposure actuation of a photodiode, exposure time sufficient in quick actuation is secured, and the good image output of high sensitivity can be realized. Moreover, by reservation, the amount of noises according sufficient exposure time to a leakage lump of light can be decreased relatively, and a good image output can be realized also from this point.

Moreover, in the camera equipment carrying such a solid state image sensor, sufficient exposure time is secured and the good image output of high sensitivity can be realized similarly.

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram showing the example of the camera structure of a system of the example of a gestalt of operation of this invention.

[Drawing 2] It is the block diagram showing the solid state image sensor of the camera system shown in drawing 1 , and the example of a configuration of an analog circuit.

[Drawing 3] It is the circuit diagram showing the example of a configuration of the pixel circuit established in each pixel of the solid state image sensor shown in drawing 2 .

[Drawing 4] It is the timing chart which shows actuation of the solid state image sensor shown in drawing 2 .

[Drawing 5] It is the sectional view showing PD and the structure of a periphery of the solid state image sensor shown in drawing 2 .

[Drawing 6] It is the explanatory view showing the potential transition at the time of charge read-out in the solid state image sensor shown in drawing 2 .

[Drawing 7] It is the explanatory view showing two kinds of examples of the conventional shutter actuation and signal read-out actuation, and an output image.

[Drawing 8] It is the sectional view showing the laminated structure of the conventional CCD mold solid state image sensor.

[Drawing 9] It is the sectional view showing the laminated structure of the conventional CMOS mold solid state image sensor.

[Description of Notations]

101 [.. An A/D converter, 105 / .. A camera digital disposal circuit, 106 / .. A compression expansion circuit, 107 / .. A storage, 211 / .. Transfer Tr, 212 / .. Magnification Tr, 213 / .. Selection Tr, 214 / .. Reset Tr, 215 / .. Discharge Tr, 216 / .. FD, 219 / .. Embedding mold PD.] .... An image pick-up lens system, 102 .. A solid state image sensor, 103 .. An analog circuit, 104

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